

**Example #11:** A power supply of EMF 6.0 V and internal resistance 0.50  $\Omega$  is used to run a motor. When the motor is jammed, the current is 3.0 A, but when it is allowed to run freely, current is 1.8 A.

a) What is the resistance of the armature of the motor?

b) What is the back EMF of the motor when running freely?

a) when jammed,  $V_{\text{back}} = 0$

$\Rightarrow$  recall:  $V_T = \mathcal{E} - Ir$  for  
batteries

$$V_T = 6 - 3(.5) = 4.5 \text{ V}$$

$\Rightarrow V_T = Ir_a \rightarrow$  only resistance!

$$4.5 = 3.0 r_a \quad \boxed{r_a = 1.5 \Omega}$$

b) find  $V_T$ :  $V_T = \mathcal{E} - Ir$

$$= 6 - 1.8(.5) = 5.1 \text{ V}$$

$\Rightarrow$  use  $V_T$  in place of  $\mathcal{E}$  in the  
motor equation:

$$V_{\text{back}} = 5.1 - (1.8)(1.5)$$

$\hookrightarrow$  from (a)

$$\boxed{V_{\text{back}} = 2.4 \text{ V}}$$